DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]The record thin film layer formed on the substrate is irradiated with a high energy beam, and a record thin film layer is made to produce a phase change in this invention. Therefore, it is related with the optical information recording medium which records and reproduces a signal.

[0002]
[Description of the Prior Art]There are some which formed the recording material thin film layer (henceforth a record thin film layer) which comprises a metal thin film and an organic matter thin film as an optical information recording medium (only henceforth a recording medium) on the substrate which carried out the shape of a disk, card shape, cylindrical shape, etc. If this record thin film layer is irradiated with the high energy beam narrowed down to the minute light spot of the diameter of a submicron order, a local change of state will arise in a record thin film layer. The art which accumulates a signal using such a change of state is already known widely. In the recording medium which especially used the optical magnetic adjuster thin film and the phase change material thin film for the record thin film layer, research and development have been briskly made from a signal being easily rewritable.
[0003]What takes multilayer film composition as shows drawing 7 the composition of a recording medium is usual. That is, in the recording medium A shown in drawing 7, the 1st dielectric layer (it is also called an under-coating layer) 2 that served as work of a light interference layer is formed on the substrate 1 which comprises a resin board, a glass plate, etc. And the record thin film layer 3 of optical absorption nature is formed in the upper surface of the 1st dielectric layer 2, and the 2nd dielectric layer (it is also called an upper-coating layer) 4 that is a light interference layer is formed on it. Next, the optical absorption efficiency in the record thin film layer 3 is raised, or the reflecting layer 5 which carries out the work as a thermal diffusion layer is formed. These each class is formed by methods, such as sputtering and vacuum deposition, one by one, and, finally forms the guard plate 7 via the glue line 6, and the recording medium A completes it.
[0004]Next, in order to record a signal, it irradiates with the laser beam which it converged on the predetermined spot diameter from the substrate 1 bottom. Then, a laser beam passes the substrate 1 which comprises transparent construction material, and reaches the reflecting layer 5 through the 1st dielectric layer 2, the record thin film layer 3, and the 2nd dielectric layer 4. Although a part of laser

beam is penetrated from the reflecting layer 5 to the glue line 6 side, it is reflected by the reflecting layer 5 and the remainder irradiates with the record thin film layer 3. At this time, the spot of a laser beam heats a part of record thin film layer 3, and changes the state of that portion. If this change of state is a phase change type, it changes with cooking temperature, but it becomes amorphous, for example with rapid heating and quenching, and crystallizes by annealing. Although a part of record thin film layer 3 tends to carry out heating evaporation at this time, evapotranspiration is prevented for the existence of the 1st dielectric layer 2 and the 2nd dielectric layer 4. The heat of the record thin film layer 3 gets across to the substrate 1, and especially the 1st dielectric layer 2 commits the protective layer which prevents the substrate 1 from becoming soft.

[0005]In order to reproduce the signal recorded in this way, it irradiates with the laser beam converged on the recording medium A. At this time, reflectance changes with phase states (a crystal or amorphous state) of the record thin film layer 3, and the quantity of the reflected ray outputted toward the exterior by the relation between a refractive index with the 1st dielectric layer 2 or a dielectric constant from the substrate 1 changes. Thus, a signal is reproduced by detecting the intensity of a reflected ray.

[0006]Now, the material and thickness which constitute each class change with the purpose of using the recording medium A, and its service conditions. For example, the thickness of the record thin film layer 3 and the 2nd dielectric layer 4 is thinly chosen as several 10 nm or less to diffuse quickly the heat produced in the record thin film layer 3 to the reflecting layer 5. Or using Au and the aluminum alloy with big thermal conductivity as the reflecting layer 5, choosing it as sufficiently thick thickness is performed to such an extent that most lights are not made to penetrate. The above-mentioned composition is usually called quenching composition.

[0007]These days, it is clear that it is important when optimizing the relative size of the light absorption amount between a crystalline region and an amorphous (amorphous) field reduces distortion. In order to realize this, it is indicated that it is one solution to make [of at most about 20 nm or less] thickness of Au reflecting layer thin, for example. This is stated to JP,1-149238,A, :"high-speed Oba light optical disc" Institute of Electronics, Information and Communication Engineers technical report Vol.92 besides Yamada, No.377, P92, or JP,5-298747,A. Using Si reflecting layer instead of the metaled reflecting layer 5 is indicated by JP,4-102243,A as a means to attain the same purpose.

[0008]

[Problem(s) to be Solved by the Invention]Now, when a reflecting layer is made thin for the purpose of using it for a high-speed Oba light, the work as a thermal diffusion layer which the reflecting layer was bearing falls inevitably, and the cooling rate of the heating unit after the end of an exposure of a laser beam falls. When a substance with low thermal conductivity is used as a reflecting layer, a cooling rate falls similarly. For example, the thermal conductivity of crystallization silicon is called about [of aluminum] 1/3 near the room temperature. Silicon itself becomes disadvantageous as a thermal diffusion layer under low linear velocity conditions, when rotating a disk especially as a recording medium and performing record reproduction operation, since thermal conductivity falls according to a rise in heat.

[0009]In heat mode record, the fall of a cooling rate influences recording sensitivity, elimination sensitivity, etc. promptly, but if it considers repeating a recording medium and performing record, reproduction, and rewriting, the limit of the number of times of a repetition cycle will also be influenced. If it explains more concretely and a cooling rate will fall, the time held at a high temperature state will become so long, and it will become easy for the Records Department (record thin film layer) to produce

a more serious thermal damage. Therefore, when it was going to use the recording medium designed for high speed recording reproduction on low-speed conditions, i.e., the conditions that a relative speed between a recording medium and a recording beam is small, there was a fault that the number of times of a permission cycle of record reproduction became small.

[0010]This invention was made in view of such a conventional problem, and is ****. Even if it makes the purpose thin, the heat dissipation state of a reflecting layer is made the optimal, and it is realizing the optical information recording medium which can raise the number of times of a permission cycle of the record reproduction of a record thin film layer irrespective of the scan speed of a recording medium.

[0011]

[Means for Solving the Problem]A substrate with which an invention of claim 1 of this application serves as a base of an information recording medium, and the 1st dielectric layer provided in the upper surface of a substrate, A recording layer which is provided in the upper surface of the 1st dielectric layer, and produces a reversible change of state between a crystal phase and an amorphous phase by the exposure of a laser beam, The 2nd dielectric layer provided in the upper surface of a recording layer, and a reflecting layer which is provided in the upper surface of the 2nd dielectric layer, and reflects a part of laser beam in the recording layer side, A thermal diffusion auxiliary layer which is an optical information recording medium to provide, is abbreviated transparence and diffuses heat of a reflecting layer to a laser beam on the upper surface of a reflecting layer was provided.

[0012]An invention of claim 2 of this application is provided with the following.

A protective layer which protects a thin film which serves as an entrance plane of a laser beam and is laminated inside.

The 1st dielectric layer provided in the upper surface of a protective layer.

A recording layer which is provided in the upper surface of the 1st dielectric layer, and produces a reversible change of state between a crystal phase and an amorphous phase by the exposure of a laser beam, The 2nd dielectric layer provided in the upper surface of a recording layer, and a reflecting layer which is provided in the upper surface of the 2nd dielectric layer, and reflects a part of laser beam in the recording layer side, A substrate which is formed in the upper surface of a reflecting layer, is formed in the upper surface of a thermal diffusion auxiliary layer which is abbreviated transparence and diffuses heat of a reflecting layer to a laser beam, an isolation layer which has the thickness which is provided in the upper surface of a thermal diffusion auxiliary layer, and does not generate interference of light, and an isolation layer, and serves as a base of an information recording medium.

[0013]

[Function]According to this invention which has such a feature, it becomes a layer system equivalent to the calorific capacity of the reflecting layer having increased by having seen from the incidence side of a laser beam and having provided the thermal diffusion auxiliary layer which is optically transparent and diffuses the heat of a reflecting layer behind the reflecting layer. For this reason, composition with a thin reflecting layer can also secure the diffuser efficiency of heat. If it carries out like this, even if the scan speed of a recording medium will fall, the spot heat accumulated by a reflecting layer is also diffused moderately, and the influence which gives the phase change of a recording layer also decreases. The flexibility on the optical design as a recording medium increases.

[0014]

[Example]It explains referring to drawings for the optical information recording medium in one example of this invention. Drawing 1 is a sectional view showing the composition of the optical information recording medium (recording medium B) in this example. In this example, it shall design by the wavelength (lambda) of the laser beam for an exposure being 780 nm. 92.9-nm-thick ZnS-SiO_2 film mixture (under-coating layer) is provided as the 1st dielectric layer 2 on the substrate 1 of the shape made from polycarbonate of a disk 1.2 mm in thickness, and 120 mm in diameter. And the record thin film layer 3 constituted from a 22-nm-thick $germanium_2Sb_2Te_5$ alloy thin film by the upper surface of the 1st dielectric layer 2 is formed. And 157-nm-thick ZnS-SiO_2 film mixture (upper-coating layer) is provided as the 2nd dielectric layer 4 on this film. A 10-nm-thick layered Au thin film layer is provided as the reflecting layer 5 on this layer, and a 156-nm-thick SiC layer is provided as the thermal diffusion auxiliary layer 8 on this layer, and each class is made into a laminating condition. The actual measurement of the optical constant (complex index of refraction) of the thermal diffusion auxiliary layer 8 is 2.5, and 156 nm of thickness is equivalent to lambda/(2n) of a laser beam about. However, n is a real part of an optical constant.

[0015]Above each class is formed one by one of the sputtering process which used Ar gas. Next, the UV-cured resin layer of about 10-micrometer thickness is applied to the upper part of the thermal diffusion auxiliary layer 8 with a spin coat method, ultraviolet rays are irradiated with and stiffened, and the protective layer 9 is formed. In this way, the constituted recording medium B enters a laser beam in the record thin film layer 3 from the substrate 1 side at the time of record of a signal. In order to show the laser beam used for record reproduction along a track to the bottom surface of the substrate 1, the continuous ditch (groove) of a depth of 60 nm and 0.6 micrometer in width spiral shape is minced in a 1.2-micrometer pitch.

[0016]Drawing 2 is a cycle characteristic between the recording medium B which has the thermal diffusion layer auxiliary layer 8, and the conventional recording medium A which does not form the thermal diffusion auxiliary layer 8 prepared for according to for comparison. The optical characteristic (not shown) of the two recording media A and B is almost equivalent. About the optical constant of each class for which it asked by survey, the record thin film layer 3 is set to 4.55+i1.35 by an amorphous state, and has become 5.57+i3.38 by the crystallized state. In the 1st dielectric layer 2 and the 2nd dielectric layer 4, an optical constant is 2.1 and is 0.18+i4.64 in a reflecting layer. The absorptivity in the record thin film layer 3 at the time of making incident light into 100% in the calculation performed from the value of these optical constants is about 39% (Aa) in an amorphous part about 53% (Ac) at a crystal part. And the reflectance as a recording medium was about 7% in about 23% and an amorphous part at the crystal part, and absorption ratio Ac/Aa between a crystal part and an amorphous part was about 1.35.

[0017]The method (what is called a 1 beam OBA light method) of recording a new signal was used for evaluation of a recording characteristic, having carried out the binary abnormal conditions of the laser beam between the peak level (amorphous-ized level) and the bias level (crystallization level) according to the record signal, and erasing an old signal. The disk which is a recording medium was rotated at 1800 rpm, and the Oba light was repeated in the position of the diameter phi 106 (linear velocity of 10 m/s). The signal was made into duty 50% of single frequency mode, and recorded two signals, f1 (6.58 MHz) and f2 (1.88 MHz), by turns. 780 nm and N.A of the object lens set the laser wavelength to 0.55. About record power, it carried out on two conditions (peak power 14mW, bias power 7mW (14/7 of

drawing 2 shows), and peak power 11mW and bias power 5.5mW (11/5 of drawing 2 shows)). The vertical axis of drawing 2 expresses the ratio (CNR) of the noise to a carrier signal, and a horizontal axis expresses the repeat frequency (number of times of a cycle) of recording operation.
[0018]As opposed to the number of times of a cycle having hardly produced change among 10,000 repetitions on low power conditions (11/5) in the recording medium A which does not provide a thermal diffusion auxiliary layer depending on power conditions so that clearly from drawing 2, On high power conditions (14/7), the fall of number-of-times C/N of a cycle was accepted. On the other hand, in the recording medium B which formed the thermal diffusion auxiliary layer 8, it turns out that change of C/N has arisen among 10,000 cycles on neither of the power conditions.
[0019]As a material used for the substrate 1, metal plates, such as transparent resin plates, such as PMMA, polycarbonate (PC), amorphous polyolefine, etc. which are usually used for the optical disc etc., a glass plate, aluminum, and Cu, or the alloy plate which made these the base is used. To use the opaque substrate 1 like a metal plate, it is necessary to make reverse built-up sequence of each class in drawing 1, and to enter a laser beam from the protective layer side. Under the present circumstances, when the influence of the light reflex from a substrates face needs to be avoided, the optical isolation layer (only henceforth an isolation layer) 10 is formed in the upper surface of the substrate 1 like the recording medium C shown in drawing 3. Although this isolation layer 10 may be a resin layer and it may be a dielectric layer, it is necessary to thicken to such an extent that the coherency of light can be disregarded.
[0020]As a means to, draw the laser beam used for record reproduction on the other hand, a concentric slot may be sufficient instead of a spiral slot, or a pit sequence can also be minced by unevenness. The 1st dielectric layer 2 and 2nd dielectric layer 4 serve to stop the heat damage of the surface of the substrate 1, as mentioned above as a protective layer, and modification of the record thin film layer 3 and evaporation can be suppressed by putting the record thin film layer 3. The 1st dielectric layer 2 and 2nd dielectric layer 4 need to have character -- high [the melting point], transparent to the laser beam used for record reproduction, and hardness is large and it is hard to attach a crack -- as compared with the substrate 1 and the record thin film layer 3. The charge of a protective layer material used in the usual phase change type optical disc can also apply this as it is.
[0021]Namely, the 1st dielectric layer 2 and 2nd dielectric layer 4, Instead of $ZnS-SiO_2$ of the 1st example, for example, oxides, such as SiO_2, ZrO_2, TiO_2, and Ta_2O_5, Sulfides, such as nitrides, such as BN, Si_3N_4, AlN, and TiN, ZnS, and PbS, $ZnSe-SiO_2$, SiNO, etc. can also use diamond membrane, diamond like carbon, etc. as selenides, such as fluorides, such as carbide, such as SiC, and CaF_2, and ZnSe, and these mixtures.
[0022]Next, the material used for the record thin film layer 3 is a phase change material which produces a reversible change of state in response to the exposure of a laser beam, and what especially produces the reversible phase change between amorphous crystals with the spot heat by the exposure of a laser beam is used for it. Typically germanium-Sb-Te, germanium-Te, In-Sb-Te, Sb-Te, germanium-Sb-Te-Pd, Ag-Sb-In-Te, germanium-Bi-Sb-Te, germanium-Bi-Te, germanium-Sn-Te, germanium-Sb-Te-Se, germanium-Bi-Te-Se, The system which added additives, such as oxygen and nitrogen, to systems, such as germanium-Te-Sn-Au, or these systems can be used.
[0023]These thin films are amorphous states when membranes are usually formed, but if energies, such

as a laser beam, are absorbed, it will crystallize and optical density will become high. In actually using as a recording medium, at the time of record of a signal, the whole record thin film layer 3 is crystallized beforehand, and a laser beam is extracted thinly, it irradiates with it, an irradiation part is made amorphous, and it changes an optical constant. At the time of reproduction of a signal, it irradiates with the weakened laser beam to such an extent that a phase change is not given to the record thin film layer 3, and intensity change of catoptric light and intensity change of the transmitted light are detected, and a signal is reproduced.

[0024]It is already shown to JP,5-298747,A by the conditions (for example, Ac/Aa>=1) which optimize the light absorption amount in a crystal part and an amorphous part that the thickness of a recording layer, etc. receive limitation. That is, regardless of whether the thickness of the record thin film layer 3 has the layer in a recorded state, or it is in a non-recorded state, it is set up so that a part of laser beam can penetrate the record thin film layer 3.

[0025]For example, when the record thin film layer 3 is constituted from a phase change material. The transmissivity at the time of inserting a phase change material film (crystal phase) into the material layer (thickness is assumed to be infinity) of the same construction material as the material which constitutes the 1st dielectric layer 2 and 2nd dielectric layer 4 is considered, and transmissivity is preferably required for a certain thing not less than 2 to about 3% about at least 1% or more. The value of transmissivity needs to be not less than about 10% as compared with the case where a phase change material film is an amorphous phase, and it is desirable to choose each thickness so that the condition may be fulfilled.

[0026]If the ingredient which it is reflected by the reflecting layer 5 and carries out re incidence into the record thin film layer 3 is lost, the cross protection of light will become small. Even if it changes some thickness of the 2nd dielectric layer 4 and the reflecting layer 5, it becomes impossible in this case, to control the reflectance of the whole recording medium, the absorption efficiency in the record thin film layer 3, etc. Then, also in this invention, a thickness limited condition which is indicated by the specification of JP,5-298747,A is applied as it is.

[0027]Au is most suitable for the reason reflectance is large, corrosion resistance is high and thermal conductivity is large as a metal thin film used for the reflecting layer 5. The alloy which made the main ingredients metal thin films, such as aluminum, Cu, and nickel, or these, and added the additive besides it can be used. The characteristics, such as an optical constant, can be finely tuned using at least one kind of material chosen from material groups, such as aluminum, Cr, Cu, germanium, Co, nickel, Ag, Pt, Pd, Co, Ta, Ti, Bi, Sb, and Mo, as an additive.

[0028]As the thermal diffusion auxiliary layer 8, it is the minimum requirement that thermal conductivity is higher than a resin material, and all the materials applied to the dielectric layer material used for the 1st and 2nd dielectric layer in the meaning can be used. However, material with it is desirable. [large and thermal conductivity and] [transparent if possible]

[0029]Y.S. Volume1 and Volume2 of the thermostat physical proper tee OBU matter of the IFI/ PLENUM publication by Touloukian etc.. According to the Maruzen Co., Ltd. publication and the 2nd paper search file of Chapter 6.5 of a chemicals manual basic volume edited by the Chemical Society of Japan, various kinds of materials are proposed besides above-mentioned SiC. For example, there are carbide etc. of at least one element chosen from the group of the nitride of at least one element chosen from the group of Si simple substance, the oxide of Ta, Zr, Si, Ta, Ti, B, and aluminum or Zr, Si, W, Ta, Ti, and B. Since thermal conductivity is highly and chemically stable about single figure as compared

with other oxides and nitrides, such materials fit especially the use of this invention.

[0030]Drawing 4 is the figure which classified various substances which are mainly concerned with dielectric materials according to the size of thermal conductivity. When there were various values by the same material name, the peak price was used. Although the thermal conductivity of periodic table 2b fellows' alkaline-earth-elements Be, Mg, Ca, Sr, the oxide of Ba, or the multiple oxide between these is large, it is not suitable from stability and a toxic viewpoint.

[0031]The optical information recording medium which can rewrite the signal of this example, Each class can be formed like the case where the usual optical thin film is formed, by the method of accumulating each class one by one and going by methods, such as vacuum deposition, magnetron sputtering, DC sputtering, ion beam sputtering, and ion plating. Whether the recording medium is made as the design can measure the reflectance and transmissivity of a recording medium which were done using spectrum meter, and it can verify them by comparing with the value calculated beforehand. In this case, although can separate absorption by the record thin film layer 3, and absorption by the reflecting layer 5 and they cannot be measured directly, accuracy can be raised by performing the same verification on at least two kinds of wavelength.

[0032]although single plate composition may be used for the composition of a recording medium like [in the case of drawing 1] -- other than this -- being also alike -- another guard plate 11 may be pasted together via the glue line 6 of a hot melt type like drawing 5. It is good also as composition which pasted the recording medium of two sheets together so that it might become up-and-down symmetry focusing on the glue line 6 like drawing 6. The composition which furthermore omitted the 1st dielectric layer 2 if needed, and the composition which omitted the 2nd dielectric layer 4 are also possible.

[0033]When requiring a certain fixed optical characteristic from a recording medium, since it is explaining in detail into the example of the JP,5-298747,A specification for which it already applied, how the thickness of each class should be chosen can use this method as it is. That is, if the optical constant of the substance which constitutes each class, and thickness will be given even if the number of laminated constitution is what, the reflectance, the transmissivity, and the absorptivity in each class can be uniquely determined by a matrix method (see Chapter 3 in for example, Kubota extensive work "wave optics" Iwanami Shoten and 1971). Therefore, if reflectance, transmissivity, and an absorptivity are calculated by changing the thickness of each class by fixed unit width, the result can be map-ized for every item.

[0034]If there is such a map, the thickness of each class which realizes it for desirable reflectance, transmissivity, an absorptivity, etc. to origin can be selected conversely. However, as few directions of the number of the layers incorporated into optical calculation as possible are desirable so that it can guess easily. That is, it not only can save the time and effort which calculation takes, but calculation precision becomes high. Then, as for the thickness of the thermal diffusion auxiliary layer 8 which is the last layer, it is preferred to choose lambda / 2n (lambda is a laser wavelength and n is a refractive index of a thermal diffusion layer) near the integral multiple so that it can except from calculation.

[0035]Even if a transparent material layer is formed in the thickness of the integral multiple which are lambda/2n to this wavelength, the optical characteristic of the whole recording medium seen from the recording surface side does not change. Even if the thickness of the thermal diffusion auxiliary layer 8 is not correctly in agreement with an integral multiple (lambda/2n), it can diffuse heat efficiently. However, it is desirable to control the accuracy of the thickness of the thermal diffusion auxiliary layer 8 from an optical standpoint to change of an about [**lambda/8n].

[0036]The complex index of refraction (optical constant) of the substance which constitutes each class can form a thin film, for example on a glass plate, and can ask for it by the method of calculating based on the measured value of the thickness and reflectance, and transmissivity, or the method of using an ellipsomter.
[0037]As another example, the medium which applied the Si film and the Ta_2O_5 film to the thermal diffusion auxiliary layer 8 was constituted, respectively. The recording medium which does not have a thermal diffusion auxiliary layer for comparison was also prepared. The substrate 1 of a disk uses the polycarbonate board of the same 1.2-mm thickness as the above-mentioned example, An 81-nm-thick Ta_2O_5 thin film is used as the 1st dielectric layer 2, The 30-nm-thick alloy thin film of germanium$_{21.5}Sb_{24.7}Te_{53.8}$ is made into the record thin film layer 3, A 154-nm ZnS-SiO_2 thin film (SiO_2:25-mol %) was used as the 2nd dielectric layer 4, and each class was formed by the method of sputtering by making a 10-nm-thick Au film into the reflecting layer 5. And as the thermal diffusion auxiliary layer 8, the Si layer, the Ta_2O_5 layer, or the ZnS-SiO_2 layer was formed in a thickness of 99 nm, 186 nm, and 186 nm by sputtering, respectively. The thickness of the thermal diffusion auxiliary layer 8 is [all] equivalent to lambda/(2n).
[0038]When the valuation method mentioned above estimated the two above-mentioned recording media, the recording medium with which all have the thermal diffusion auxiliary layer 8 as compared with a recording medium without the thermal diffusion auxiliary layer 8 showed the long number of times of a cycle. In comparison of three materials, a long time found most the number of times of a cycle of the recording medium using the Si layer which has the biggest thermal conductivity.
[0039]
[Effect of the Invention]As mentioned above, according to this invention, even if it makes thin the reflecting layer which constitutes some recording media, the heat storage condition of the laser beam in a recording layer and a reflecting layer can be made the optimal, and record reproduction of the signal can be carried out on linear velocity conditions low at the time of record reproduction. The permission repeat frequency of record reproduction is increased, the signal level in a phase change becomes difficult to deteriorate, and the outstanding recording medium can be realized.